



Building a Homestead Root Cellar



by Brian Thomas & Teri Page

Introduction



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Four years ago our family moved to NE Missouri, where we purchased a parcel of raw land and began the process of creating an off the grid homestead from scratch. We camped on our land with our two young children, building a tiny house and setting up basic infrastructure such as an outdoor kitchen and a composting toilet.



Among our bigger challenges was keeping our food cool and fresh. We did not have electricity at that time so we couldn't run a refrigerator on our land. Our solution at that point was to store a chest freezer on a friend's property and freeze jugs of ice that we would place in a cooler with our food. While this solution worked, at some point in our off the grid journey we began to fantasize about a root cellar large enough to store large quantities of food, overwinter vegetables, and, not insig-

nificantly, protect us in severe storms.

The larger our garden grew, the more food we had to store for the winter, and the more urgent the need for a root cellar became. We began designing and researching the best method of building for our hilly off the grid site. In September 2015 we broke ground, and construction began in earnest. Our root cellar took several months to build, although it was another ten months before we

fully covered it, and cost approximately \$2500. While we have indeed spent a few hours in the root cellar seeking shelter from strong winds or tornado warnings, its primary use is as a low-tech walk-in cooler in which we store cured meats, aging cheeses, vegetables, fruits, barrels of rain water, and various ferments.

In this book, we will share with you the exact steps and how-to's to build your own homestead root cellar. *Building a Homestead Root Cellar* is organized into three chapters:

In the first section, we'll take a look at the **basics of root cellaring** - how it works, the optimal conditions for food storage, and some food that you can safely and easily store in your root cellar.

In the next section, we will talk about **planning your root cellar**, from size to siting to materials.

And in the final section, we will walk you **step-by-step through the process of building** your own root cellar from start to finish. We've included dozens of color photos and illustrations so you can visualize each step of this process.

We also have a list of **books and resources** that were helpful to us, and can deepen your understanding of the hows and whys of root cellaring.

Our root cellar is an invaluable part of our homestead, allowing us to become more and more self-sufficient. It was one of our best homestead investments and we hope it will become one of yours.



Why Root Cellar?

A root cellar is a traditional food storage method that preserves food by controlling temperature, humidity, and light. While today's modern "root cellar" is your home refrigerator, traditionally, root cellars were built into the ground, often into the side of a hill, and covered with earth. Root cellars were essential parts of homesteads in the days before fresh produce was available in supermarkets year-round, and they remain a wonderful way to store food without the use of electricity.

For gardeners with harvests bigger than any refrigerator can hold, a root cellar allows you to store large quantities of food without the effort of canning, freezing, or dehydrating.

Be sure to include a fall garden in your yearly plan and grow extra vegetables for root cellaring. Many seed companies will designate good storage varieties, and it's worth seeking these keepers out. In our climate, we start our fall garden in July. It takes a little extra planning, but growing some extra food for the fall and winter is well worth the effort!



Even if you do not have a large garden, Farmers Markets can be a great source of fruits and vegetables to fill your root cellar. Some farmers are willing to offer bulk discounts, especially if you are willing to travel to the farm for pick up. For the past few years, I've purchased winter squash, sweet pota-

toes, storage onions, Asian pears, and root vegetables from a market gardener. Although I have to wait until the end of the Farmer's Market season for the true bargain prices, I have been able to fill my root cellar with perfectly edible fruits and vegetables that were not considered "attractive" enough for customers.

You might also consider visiting a nearby orchard and picking apples or pears for root cellaring. In our area, Arkansas Black and Winesap apples are grown as superior keepers. Ask your orchardist what he or she would recommend as good storage fruit.

If you have dairy animals or access to quantities of milk, consider making simple hard cheeses to last into the winter and early spring during the season when many dairy animals are no longer producing milk.

Nothing beats the joy of walking into a root cellar in February or March and "harvesting" a meal of carrots, beets, and potatoes that look almost as fresh as the day they were picked. With a bit of advance planning, your root cellar will overflow with abundant produce!



How Does a Root Cellar Work?

Root cellars are designed to provide dark, cool, moist environments in which vegetables and other foods can be stored without electricity. Essentially it is an underground cave with a door. The earth surrounding this chamber has enough mass to stabilize an average temperature, keeping it from freezing in deep winter and keeping it cool during the hot summer months.

So while these are very low tech solutions to food storage issues, and you almost can't go wrong as long as you bury a space underground, some specific conditions are required:

Temperature

The ideal root cellaring temperature is between 32 and 40 degrees F, but it's important to realize that there are no temperature controls on your root cellar. Luckily, root cellars tend to hover somewhere in that range. Certain foods store better in cold temperatures, others in slightly warmer temperatures. We'll take a closer look at the optimal temperatures for some popular storage crops in the next section.

Humidity

A very high (90-95%) humidity environment will provide the best storage environment for most leafy vegetables and root crops. You may need to add moisture to bring the humidity up to the appropriate level. Some ways of doing this are:

- Planning an earthen or gravel floor for your root cellar, which can be sprinkled with water occasionally, if needed
- Placing dishes of water in your root cellar
- Packing vegetables in moist sawdust or sand

A small digital thermometer that gives a humidity reading or a hygrometer, which measures relative humidity, are great tools to have on hand for root cellaring.

Ventilation

Good ventilation is important in your root cellar, as it helps prevent mold growth and moves ethylene gas out of the cellar. In the third section we will talk about how and where to install your vents to ensure this air flow.

Preparing Food for Storage

Successfully keeping food in a root cellar requires a bit of extra care to ensure that the food will remain fresh for months. Here are some guidelines for preparing to store food in a root cellar:

- Pick at the peak of freshness - Fruits and vegetables are ripe when they have fully developed their color, flavor and texture. Ripe produce is best for storing, as well as for other forms of preservation.
- Choose late-maturing crops over early-maturing ones for best storage - Again, this is where seed catalogs are going to be very helpful. Seek out varieties that are late-maturing or specifically designated as keepers.
- Harvest as late in the season as possible, but before the first hard frost - Hard frosts will damage certain crops, so be sure to watch the weather forecast!
- Handle food very gently to avoid bruising - This is very important, as fruits and vegetables with bruises, cuts, or nicks will not store well.
- Properly cure food according to their specific needs - For instance, potatoes should be cured at a temperature of 45-60 degrees Fahrenheit and a relative humidity of 85-95% for two weeks. During the curing process, the skin of the pota-

atoes will thicken and any minor nicks or scratches will heal over.

- Store only the best fruit and vegetables; if you see any signs of rot or bruising, eat them fresh or can them instead.



The good news is that you can save yourself work by *not* washing the fruits and vegetables that you plan to cellar. Instead, simply brush off extra dirt and store the produce in crates, mesh bags, baskets, or any other container that allows for ample air circulation.

Carrots, beets and other root vegetables may benefit from being stored in buckets with layers of sand, straw, or sawdust sandwiching layers of vegetables.



Optimal Conditions for Storing Fruits and Vegetables

The foods that are best suited for root cellaring are (you guessed it) root vegetables and other foods that prefer cool temperatures and very high humidity. Each fruit or vegetable will have its own particular temperature and humidity needs. Of course in one root cellar, it is hard to please all the vegetables! And other than moving food from the back chamber to the front, you really don't have much control over the temperature of your root cellar through the year. Don't stress too much about it, and do your best, and each year you will find which crops do best for your cellar. Food may not store as long in non-optimal conditions, but it will still keep for months.

One important consideration is that as some produce ripens, for instance, apples and pears, they give off ethylene gas, which decreases the storage life of other fruits and vegetables. Proper ventilation will help move ethylene gas out of the root cellar, but a better solution is to simply not store your apples and pears in the cellar too near other foods.

Some great choices for your root cellar include: Cabbage, Chinese cabbage, Beets, Parsnips, Carrots, Potatoes, Brussel Sprouts, Cauliflower, Turnips, Jerusalem Artichokes, Apples, and Pears.

Sweet potatoes and winter squash are great storage crops that last for months; however, these should not be stored in a root cellar, but rather in a *dry* and cool location.



Below I have shared the optimal storage conditions for a few popular storage fruits and vegetables.

Cabbage (Head and Chinese) - In mild climates, cabbages will keep well in the garden with a heavy mulch. Harvest in ad-

vance of a hard frost and store either by hanging the entire plant upside down by their roots, or breaking off the head and storing in a basket or on a shelf. We have had great success keeping both Chinese and head cabbage for months when stored in cold and moist conditions.

32 to 40 degrees Fahrenheit

90 to 95 percent relative humidity

Apples and Pears - Apples and pears store well in cold, moist conditions. Because apples and pears give off ethylene



gas as they ripen, you may store them together, but away from other crops.

32 to 40 degrees Fahrenheit

80 to 90 percent relative humidity

Beets, Parsnips, Turnips, Carrots, Rutabaga, and other Root Vegetables - Again, in mild climates, these root crops can be stored in the ground, covered by a heavy straw mulch.



But if you regularly experience temperatures below 28F, you can lift the vegetables and store them in cold and very moist conditions in the root cellar. (Parsnips are the exception in that they will actually grow sweeter when left in the ground all winter.) To store, cut the top greens off to 1-2” and layer damp sand, sawdust, or straw in a box with your root vegetables. This will help keep the humidity higher than what your root cellar might be able to maintain.

32 to 40 degrees Fahrenheit

90 to 95 percent relative humidity

Potatoes - Potatoes are very susceptible to sprouting if exposed to any light or to ethylene producing crops like apples or pears. Try to store your potatoes in bags, or under a lid to reduce light penetration. Note that their humidity requirements are quite different than many of the root vegetables.

32 to 40 degrees Fahrenheit

70-80 percent relative humidity

Onions - Onions prefer cool and dry conditions, which will put them at odds with many other root cellared vegetables. I have successfully cellared onions, but also have had success storing them in a small storage area adjacent to our mudroom. Here they were able to stay dry and cool. Regardless of whether you decide to store them indoors or in your cellar, be sure that they are adequately “cured” after harvest. I like to

lay them flat in a well-ventilated area for 2-3 weeks until the skins are dry.

32 to 35 degrees Fahrenheit

60 to 70 percent relative humidity

There are so many more fruits and vegetables that can be cellared. Check out the additional resources in the back of this book, or your local extension office for more information!

Now that we have talked about the basics of filling your root cellar, let's get started with the how-to's of planning and building!

Planning Your Root Cellar



Size and Siting

A root cellar can be almost any size, from as small as a buried trash can in your garden, to the huge underground aging caves you might find at modern wineries. Think about what you are trying to store, and what you might want to store in the future. It's a lot easier to build your root cellar with a little more square footage now than to try and add on to it later.



We knew we wanted space for several bushels of apples and other fruit that we pick in the fall, as well as all the root crop vegetables and cabbages that we grow. Crops and jars of fermented vegetables need space on the floor or on shelves. We knew we needed space for shelves of aging cheese, some of which need 6 months to a year of aging, and hanging space for our cured

meats. We occasionally brew beer, hard cider, or wines, and the cool root cellar is the ideal temperature for fermenting and storing such beverages as well. And finally, since we live in an area of the Midwest with the potential for tornadoes, we knew we wanted enough space for our family and neighbors to weather any dangerous storms.

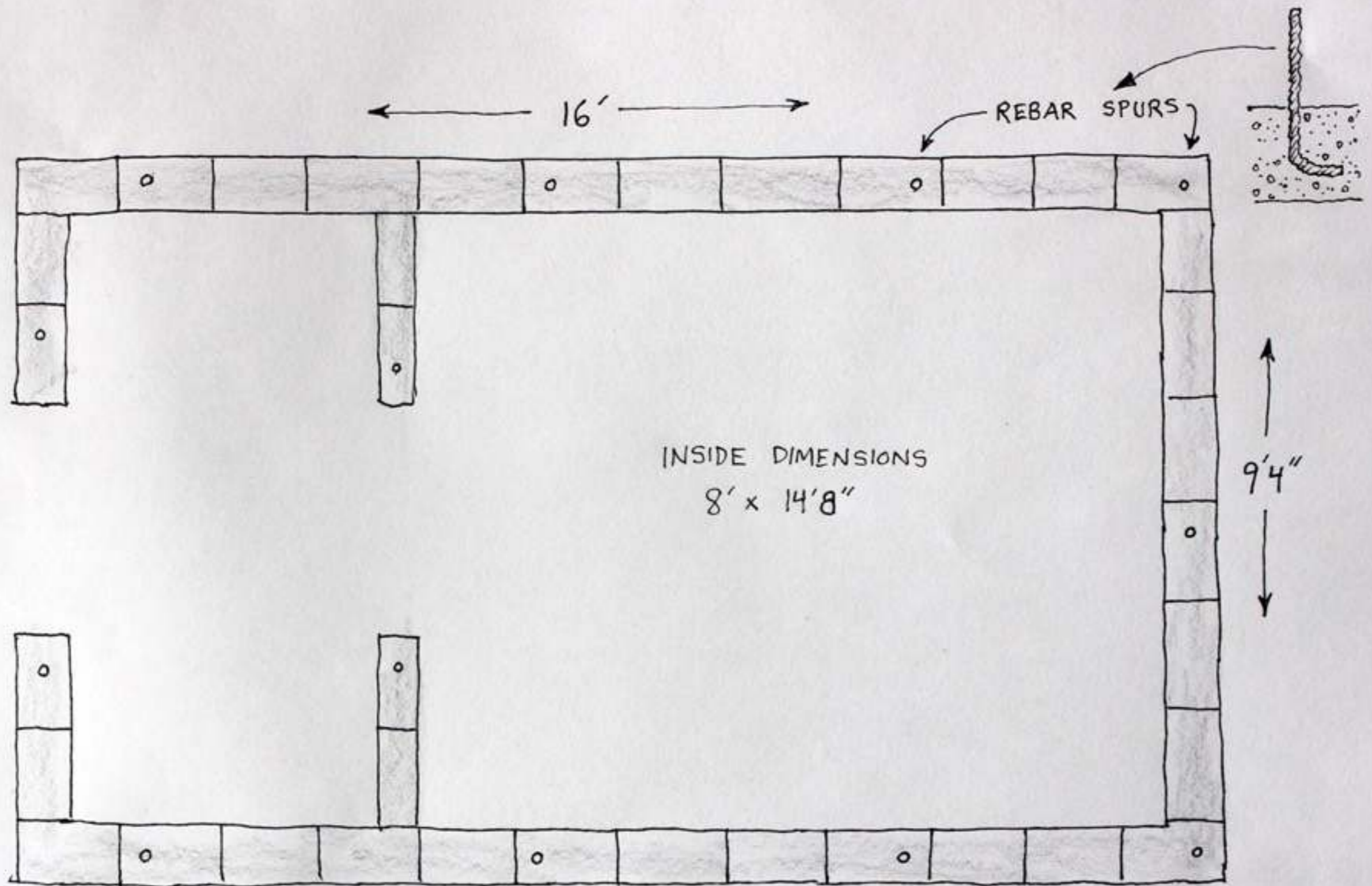
So how do you actually come up with the

size you want? If you have any rooms or small sheds that you can stand inside and visualize, that helps. Some people like to get graph paper and draw in exact floor plans with shelves and walkways figured in. I have a 10x10 tool shed that gave me a sense of the space I wanted, and then I added a bit more. For height, I wanted to be able to stand upright

without hunching over, so I made our root cellar ceiling a few inches higher than my head. I figured that certain costs were not going to change based on the size, like the cost of renting an excavator or the delivery fee for the concrete pour. Enlarging the cellar meant only the cost of a few dozen more concrete blocks and a bit more concrete. Our root cellar is on the larger size for a single family homestead, but I also knew I didn't want to be wishing for more space later. In the end, we decided on an interior dimension of 8 x 14 feet and a height of 72 inches, and an inner wall to divide the cellar into two chambers. For the inner block wall I used thinner 4 x 8 x 16 blocks to maximize usable space.

On the next page you will find the plan layout for the root cellar I built. As you can see, it is laid out in whole concrete blocks, which means the width and length are in multiples of 16". If you want a root cellar larger or smaller, simply adjust the number of concrete blocks in this diagram. If you count, you'll see that mine required 34 full size blocks per course, plus four thin blocks for the inner wall per course. I built my root cellar with 9 courses of block, so the total inside height is 9 courses @ 8" tall, or 72 inches.

Siting your root cellar will of course be very dependent upon the lay of your land. Ideally it will be situated on a north facing slope to keep the open wall out of any warm summer sun. Also, site it as near your home as you can, as you will be making trips to it daily for your meal preparation.



DIMENSIONS AND ACTUAL BLOCK LAYOUT FOR FIRST COURSE

Design

The elements of a root cellar are rather simple: an underground cave with a way to get into it. There are many kinds of root cellars; some that are merely buried containers in your garden, some that are sectioned off in an existing house basement, and others that are built into the ground with either steps down into them or with a walk-out doorway and wall.

All have their applications, but this eBook will detail the *building of a root cellar dug into a hillside with a walk out door*. The drainage issues are easier to address in this design, and you don't need to deal with steep stairs down.

If you don't have any hillsides on your land, it's not impossible to build a root cellar into level ground, but you need to deal with drainage issues thoroughly, diverting surface water away from the cellar adequately and installing one or more french drains below the floor of your cellar to deal with underground water drainage. There are designs for this available in some of the books and resources listed at the end.

Although your root cellar is essentially a cave, there are some design elements that are important to consider when planning your root cellar. The first is that you do want some amount of air circulation to keep the cellar from becoming stagnant. This is accomplished by installing vent holes low in the walk-out wall and a vertical vent shaft in the back roof. A fan isn't necessary, as the warmer air will rise out of the vent shaft and



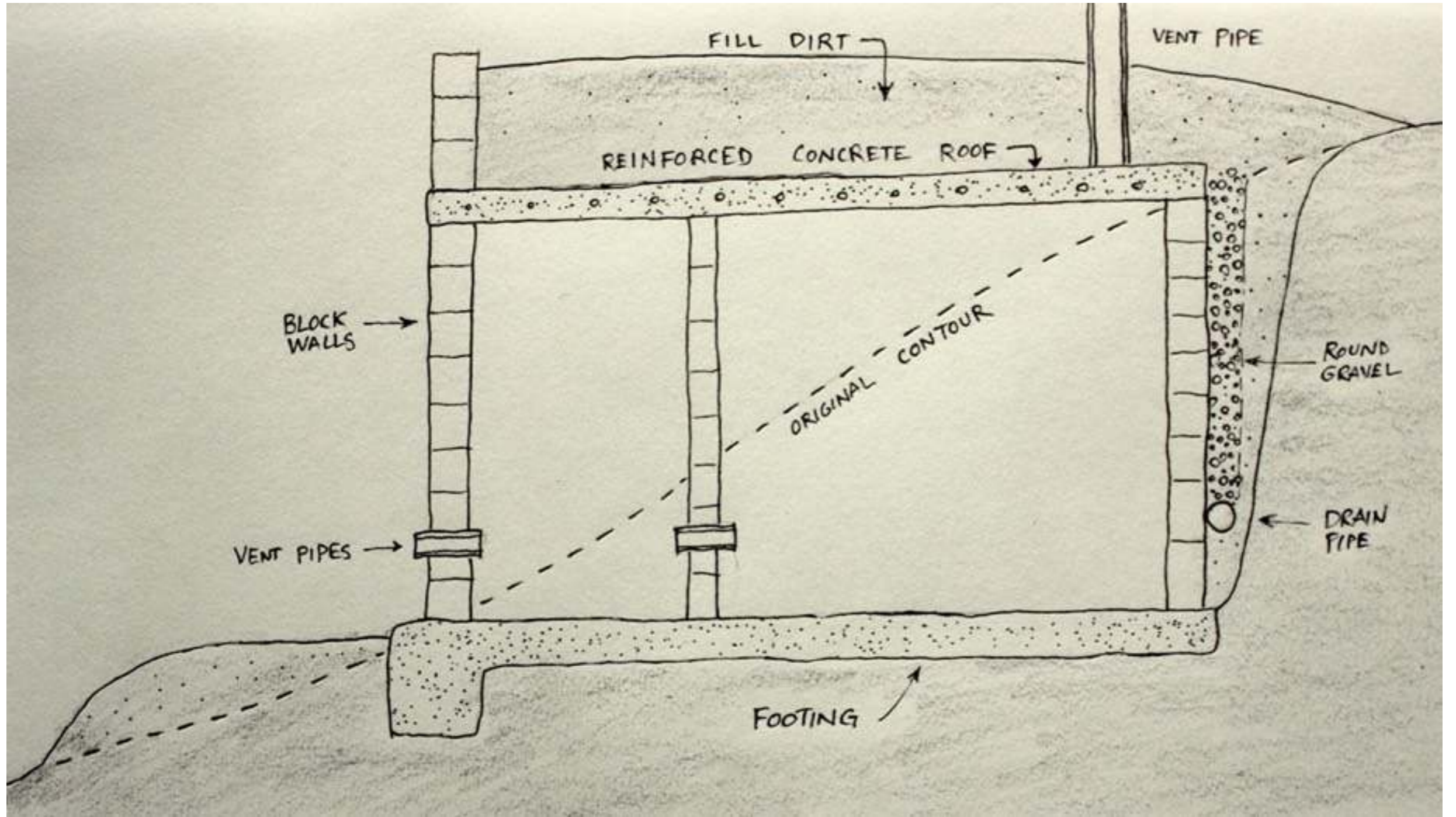
pull cooler air in from the outside through the lower vent holes. However, you may be able to slightly regulate the inner temperature at different times of the year by either dampening off some air flow, or increasing it with a small fan.

The second design element that I included is the anteroom and inner door. Though not essential, it works to mediate the inner room's temperature by providing a buffer from the out-

side temperature fluctuations, since the walk-out wall is exposed to the outside air and not buried under earth, and in my case not insulated either. A side benefit to this design is that you end up with two different temperature storage rooms. My outer room, in the winter, functions as a very cold refrigerator (that sometimes dips below freezing, as a warning), and is perfect for things like apples which do best in just above freezing temps, while the inner room hovers gently around 45 degrees F. In the summer, the outer room is closer to the outside temperature, and provides that buffer which keeps the inner room cooler and closer to that cool cave-like environment you are striving for.

It's important to point out that, tempting as it might be, you shouldn't build a structure on top of your root cellar roof, unless you carefully consider how it might affect the temperature inside. An unheated tool shed built on top of your root cellar for instance would allow your winter time temperatures to penetrate the ceiling of your root cellar, since you wouldn't have the thick layer of earth covering that this design calls for.





Materials

With any new building project, it's important to weigh the benefits and costs of a range of potential building materials, and consider the purpose and life span needed from the building, as well the availability of salvaged or recycled materials. We chose to build a strong, permanent root cellar that will function here for generations, even though it required purchasing concrete and some blocks (we had salvaged about a third of the amount we needed). Knowing that we would never have to worry about the roof or walls leaking or caving in was a consideration we felt was worth the extra cost.

But that doesn't mean a more vernacular design wouldn't be appropriate in some cases. You could build the walls out of a strong rot resistant wood like black locust, though eventually any wood will decompose in the damp underground conditions. But such a root cellar would be significantly cheaper and require less energy intensive cement products, and you might be ok with a shorter life span. I've heard of people burying entire shipping containers under ground, but these too would eventually rust through in the damp underground moisture. But if you had one readily available, then the costs and benefits might weigh in that direction.

In the next section, we share a general material and expense list for our root cellar project, to give you a rough idea of where and how we spent our resources to build it.



Building Your Root Cellar



Root Cellar Plans

This section of the book will guide you, step by step, through the process of building a root cellar identical to the one that sits happily buried on our property. However, it would be quite easy to modify these plans for your own needs, with just a little bit of figuring and simple math skills. If you don't need a root cellar quite so big, then adjust the dimensions, and recalculate your materials. Remember that concrete blocks are designed so that including the mortar joint, they are 8x16 inches, so make your cellar dimensions in increments of 16 inches so you don't have to cut fragments of block on every course.

You could leave out the inner wall and door and make a single chambered cellar, if desired. If you are ok with a lower ceiling and don't mind bending over when you are pulling out some ripe apples to eat in late February, simply lay one or two less course of cinder blocks and you will have a ceiling 8-16 inches lower. Or add another course if you'd like a lofty ceiling and you are taller than me. You will need to roughly factor in the height when you are excavating your site, but none of it is rocket science, and there is a lot of flexibility in building something like this. Remember, in the end, you are just building a big cave with a door and covering it with dirt.

Though it should be clear from the photos and diagrams, you must build this root cellar into a hill side. As I stated before, it's not impossible to build a root cellar straight down into a

hole you dig, but the drainage issues need to be thoroughly dealt with or you might end up with a nice swimming hole instead. If you wish to put in a root cellar on very flat level ground, refer to one of the books in our resource section that has plans for such a cellar.

Important disclaimer: We are competent builders but we are *not* engineers. We live in an area without local building codes or permitting. You must do your own research and look into your local building codes and zoning requirements before you start digging, and if needed, have your plans confirmed by the appropriate building professional.

Materials List

Listed here is a rough material and cost list, to give you a general sense of where we spent our money on this project. I don't break it down into too much detail because you should work out those calculations yourself, based on the actual size you decide to build, your already acquired materials on hand, and your concrete pour calculations. I already had some reclaimed used blocks, as well as assorted used lumber I used for building the forms, that aren't shown here since I didn't purchase them.

Excavator rental for 1 day to dig hole \$347

Concrete delivery for the footing pour \$242

Various loads of gravel for drainage filling \$100

Concrete blocks, rebar, mortar mix \$925

Plywood and lumber for roof form \$80

Concrete delivery for roof pour \$374

Skidsteer rental for 1 day to cover the cellar \$381

Misc. Hardware, screen, screws, PVC U-piece \$76

Site Layout and Excavation

Siting your future root cellar isn't difficult in theory, but can be challenging to actually layout on the ground. Keep in mind, again, that this is a walk-out root cellar and needs to be built into a sloping hillside. The cross-sectional diagram in the previous section shows how you are essentially excavating out approximately half of the volume of your cellar, and then later using that earth to bury the finished cellar. You could choose to excavate deeper into the hillside, which would entail a larger amount of earth moving and a deeper cellar; or alternately, if you fail to excavate deep enough, there won't be enough fill dirt to cover your cellar. But between those extremes you have some flexibility.

Start by placing four corner posts at roughly 2 feet larger than the root cellar dimensions. In our case, this was 11 x 18 feet, and measure the diagonals to square it up. The reason these dimensions are larger than your final root cellar is to allow for a slight sloping of the sides of the hole. The important measurements to end up with are the dimensions at the *bottom* of the finished excavated hole. You could hire an trained excavator to do this for you, but if you have the inclination, it's not too hard to do it yourself by renting a small excavator, which is what we chose



to do. It might not be the prettiest hole, but it did the job. In our case, we had to clean up some of the edges near the back to get the required clearance for the footing forms. The excavated fill should be piled as close to the hole as possible to make it easier to fill back over the finished cellar.



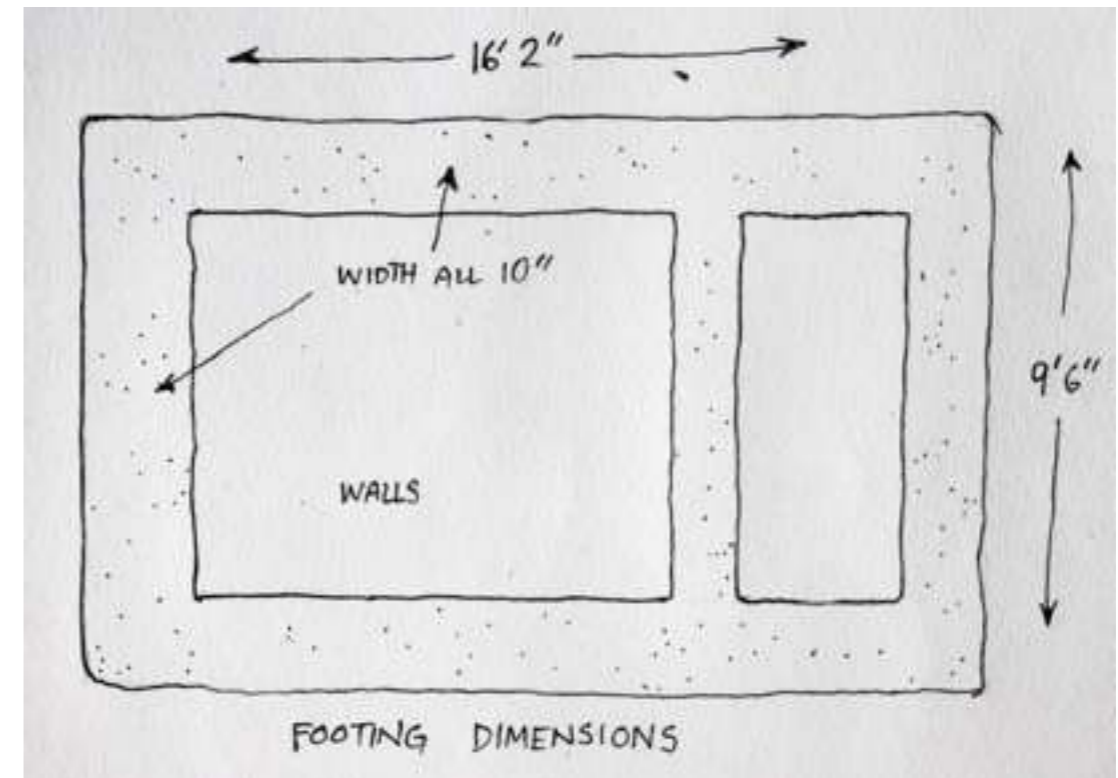
Preparing the Footing

Begin by placing four corner posts at the outside dimension of the root cellar footing, and stretch a string line around them as a visual guide to see where you might need to adjust the excavation. Allow for an extra inch all around the actual dimension of the block wall. Square it up, and if needed, fine



tune with a shovel to allow space for the footing forms. We chose to make a hybrid footing form by digging a partial trench and completing the top of the footing form with 2x lumber. You could also dig the footing trench deep enough for the footing pour or build a footing form entirely above the

ground. Remember, it doesn't need to be pretty since no one will ever see it, but make sure it is squared up and relatively level. See the below diagram for the dimensions I used. I



came up with these outside dimensions by adding an inch on either side of the dimensions from the diagram of concrete blocks in the previous section. You'll notice that by adding an inch on either side of the 8" thick block wall gives you a footing that is 10" wide. (the inner wall is only 4" thick, so that section of the footing is 6" wide).

You can see in the photos the partially dug trenches, finished off with scrap form boards to get the depth of concrete footing you want. I was aiming for the footing form to be 8-10 inches deep. Stake it every few feet so it is solid, and for ease of disassembly, try to place the screws where they won't be buried in the concrete; that is, on the outside of the form boards. Then place the inside form boards so the footing is about 10 inches wide, thus giving an inch wider on either side of the 8 inch block wall.



Most all of the footing will end up being well below the frost line, except for one spot: the front wall that is exposed to the elements. Because that spot has the potential of frost heave, I chose to excavate that trench deeper, almost 20-24 inches, then fill half of it with gravel for drainage. The footing still came out to 8-10 inch depth, but was poured over that gravel

bed. If you live in a very cold climate, you might want to dig that even deeper, or even make the footing in this section extend below your frost line.





Footings usually call for reinforcing rebar to be placed throughout the entire footing space, but I felt that it would be strong enough without it, and I was trying to save money and resources. I did put some in under the inner doorway as well as under the front outside wall, since those were spots I could imagine might need extra strength.

Measure out and mark the spots where the vertical rebar spurs will be placed, so you don't have to do the measuring after the concrete is poured. See the diagram in the previous section for the placement I used. Pre-cut and bend your roughly 16" L-shaped rebar so they are ready.

Notice that I chose to install a wooden insert to create a step down on the in-



ner door, so you wouldn't have to step up and over the sill. Though not necessary, I think it makes for a nice walking experience in the cellar. Or you could raise the inner floor level to be equal to the footing all around.



When all is set, pour the footing. If you have access to a small concrete mixer, it would be fairly easy to mix and pour it yourself. I chose to have it delivered since it wasn't much more costly after factoring in the price of renting a small mixer. If you do this, you'll need to calculate how much concrete to have delivered. See the section on pouring the roof for volume calculation.

When the pour is finished and the surface screeded to the top of the form boards, place your L-shaped rebar spurs in the marked places so they will lineup with the holes in the blocks on the first course. Let cure for a couple days, and then remove the form boards.

Here you can see part of the finished footing with the form boards removed and some of the rebar sticking out. It's a safety measure to put some sort of top on the rebar in case you were to fall on one while working on the building site. I just cut small blocks of wood and drilled a 1/2" hole part way in and stuck them on over the ends.

And finally, you can see I bought and spread out a finer grade of gravel for what will be the inside of the root cellar. It's nice to do this now so you are not walking and working in mud in case it rains.



Building the Walls



It's not in the scope of this tutorial to instruct you how to lay concrete block. If you never have, check out books from the library and watch some YouTube videos to get an idea. I will say, however, that this is a good project to start with, since you will get to bury any cosmetic mistakes under the ground. I made sure my walls stayed as plumb and level as possible, but I also didn't worry too much about slight waverings as I went along. Remember, you are building a cave, not a fancy outbuilding. That said, the inner walls of your root cellar will be visible, so keep that in mind as you clean up mortar joint lines.





Mark on the footing where you have your rebar spurs, so you know which columns to fill with concrete and rebar later. Once your walls are to their full height, you won't be able to see down into the cavities to find them.

Since the dimensions are laid out with respect to the 8x16 blocks, you

shouldn't need to cut any blocks except on the front wall doorway and the inner wall doorway. When it comes time to lay the doorway block, measure the size you'll need and cut a



block using a skill saw fitted with a diamond masonry blade, or even an angle grinder fitted with a small diamond masonry wheel.

One important detail is to build in vent tubes through



the front wall and the inner wall if you are building one. I used PVC pipe cut about 2 inches longer than the thickness of your



block walls, so there was space to attach mouse proof screen. Simply use your diamond blade to cut a square hole big enough out of a corner of a block before you set it, and then pack the pipe in there with mortar. It takes some finesse and gloved finger work. I installed 3" pipe, because I had some scrap and it seemed right. It's important though that the cross sectional area of these two pipes is roughly equal to the cross sectional area of the vertical pipe through the roof.

If you plan on having electricity in your root cellar, embed an appropriately sized PVC conduit pipe through one of the block walls, and thread some wire through before you cover the cellar.

As you prepare to lay your final course, cut some 7 inch wide strips of metal window screen (you can buy this bulk from the hardware store) and lay these down over the block cavity columns that don't have the rebar spurs. As you lay the final course of block, this screen gets sandwiched in the mortar and blocks off those columns, so when you pour the roof, the concrete doesn't spill down and fill the entire cavity of the wall. You could omit this step if you want, but all those columns will fill with concrete as you are pouring your roof, which is an unnecessary expense. If you leave out the screen, you'll need to figure into your calculations how much concrete you will need to fill all the columns as it will add quite a bit extra to your final figure.

When your last course is set and cured, it's time to place the vertical rebar and pour those columns. (You might notice from the photos that I set the rebar when I was only half done and partially poured the columns. The only problem with do-



ing it this way was that I had to heave the blocks up and thread them down over the rebar.) Remember, these will not have screen and will be open all the way down. Cut the rebar so it extends another 1.5 feet above the top of the wall, and simply drop them in the columns that you had marked earlier that have the short rebar spurs coming out of the footing. Then, mix up some concrete in a wheel barrow and start filling. I shoveled into a small bucket, then used that to pour into the wall. As it fills, wiggle the rebar regularly to settle the wet concrete into the cavity. Fill these columns to the top with concrete.



Drainage

Good drainage is essential to protect your walls from frost heave damage in the winter, and also to keep your root cellar from filling with water in heavy rains. Luckily, with a walk-out cellar built on a slope, it's easy to ensure proper drainage, using perforated drain pipe. Lay in a simple U-shaped pipe -



you'll need two 90 degree elbows at the back corners to do this - and allow some pipe to extend beyond the front wall. I waited to put pipe in place until I had laid the first course or two of block. Make sure that the pipe is slightly higher in the rear of the cellar, so there is a downhill slope to them as they extend toward the front of the cellar. If neces-

sary, fill in around the back to raise the grade and ensure this slope.

Later, after the wall is built, you will need to fill in above the pipe with drainage round gravel, preferably with some landscape fabric to prevent silting and clogging with dirt. I found that it was helpful to use a piece of scrap plywood to act as a divider between the gravel and the fill dirt. I would alternately fill in on either side, and then pull the plywood out and start over with that process in a different spot.

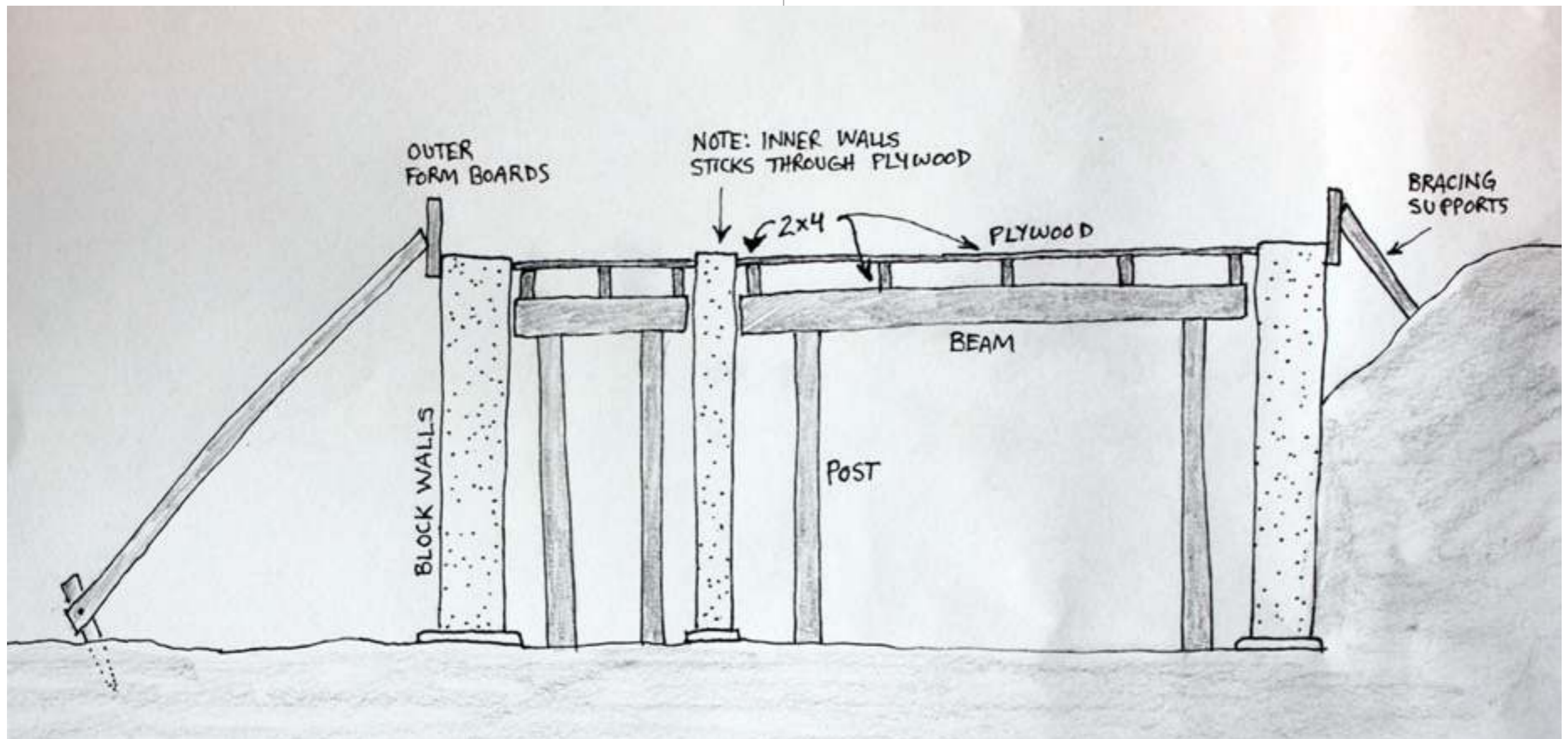


As you can see from the photos, I also chose to start filling in the drainage gravel and dirt fill even before I had completed the full height of the block wall. Doing so allowed me a place to stand on the outside of the wall while I continued to lay block courses up to the final height.

Building the Roof Form

Building the roof form is an interesting bit of carpentry, mostly because all of it is temporary and will not be there once the root cellar is finished. You are in essence building a big shallow pan for the concrete to fill and cure right on top of your

walls. For the outside, use long continuous 2x8 boards to create a wood wall around the block wall, tight against the outside. I aimed for a 5 inch thick slab, so I had about 2.5 inches below the block and 5 inches sticking above. This is where



you can also hide any fluctuations in the top level of your wall if it didn't end up perfectly level. In order to keep this form wall in place, you need to place diagonal supports from the ground up to the form, every couple feet. You can see in the photo, it doesn't need to be pretty or organized, just sturdy. This is a good use for any scrap lumber you have around.

For the inside "floor" of your roof form, you need to build a structurally sound support that can hold the thousands of pounds of wet concrete that will flood on top of it. I chose to be over cautious and cut posts and beams to span the long length of the cellar in three places: the center line and along each wall about 6 inches out. Note that the interior dividing wall requires you to build those along the wall post and beam structures in two parts. Then on top of those beams I placed 2x4 supports on edge across the short span of the cellar, every 2 feet roughly. None of this has to be exact, or look



pretty. I cut posts from old saplings that I had cleared from the land. See the above diagram.

Begin by marking a chalk line all around the inside of your block wall 1/2 inch below the top. In my case, since I had an imperfect wavering top, I chose to mark 1/2 inch below the lowest section of wall. Use a long level or sight level to mark this line all around the inside of the wall, and snap a chalk line. This will be the top of the 2x4 supports. Mark down 3.5 inches and make another line. This will be the top of your beams. Measure down again the height of your beams and this will be the top of your posts.

Start with the two beams along the wall. At each post point, measure down and cut a post to that length, or a little less, to allow sliding some block or shim pieces under the bottom of the post for adjustment. Place the beam across the top of the



posts and fasten with a couple screws at each post. Repeat this on the other side. Now cut your 2x4 supports to fit the roughly 8 feet wide span and place them along the top of the two beams perpendicularly, and fasten from below with screws. Remember to place all your screws from below inside, since once the roof is poured, you won't be able to access any of this structure from above.

Next, measure and cut posts to hold up the center beam and shim it up under the 2x4's and attach with screws. Take out any wiggles with shims underneath the posts or beams. It won't need any diagonal bracing since the block wall will stop any shear movement of the structure.



Finally, cut and set down the plywood floor on top of the 2x4 supports. With any luck, your block walls will be exactly 8 feet apart, so this should require minimal cutting. I wasn't that

lucky, and had to trim an inch off here and there to make them fit. Remember that your inner block wall needs to stick up through the plywood, so it can bond with the roof pour. (Again, see the diagram. Cut the plywood to fit around the inner wall.) If any of the plywood seems like it flexes too much, like around that inner block wall, place another 2x4 under it, or scraps of lumber. Attach the plywood to the 2x4s from underneath with a few screws to keep it secure.

One spot that needs attention is the space right above the outer door, since at that edge there won't be any block support underneath it. Place either an extra piece of rebar across there, or an piece of angle iron, tucked against the outer form board for structural support. I used a roughly 3"x3" piece of angle iron which you can see in the photo, with old red paint.

If there are any gaps between the plywood and walls, or the outer form boards and the block walls, that seem big enough for wet concrete to leak through, plug them up. I used scrap bits of plywood or thin wood shims, and in some cases, cut strips of foam from an old pool noodle. Even folded up cardboard would work.

Other details you might want to add: embedded wood blocks for attaching light fixtures or hanging hooks. Note the angled cut in the block of wood that will keep it from sliding out of the cured concrete. I used white oak for rot resistance, and kept them no thicker than 1.5 inches. Think of where you might want lights, or think about placing them so you can attach hanging bars from the ceiling to hang your curing salami. It's not impossible to attach things into a concrete ceiling with special screws, but screwing into wood is much easier.



The last very important ventilation detail is to screw (from below) a round block of wood that fits into the vertical air vent pipe you will use to vent out of the back of the root cellar ceiling. I cut a piece of firewood that just fit my 4 1/2" diameter

PVC pipe. Make sure you place your vent pipe onto that before you pour your roof.



Set Rebar and Pour the Roof



The construction term for your roof is a “hanging slab” The poured concrete needs no support once it has cured, so every bit of wood support structure you have built under it will be removed, leaving a smooth concrete ceiling usually with the imprint of the plywood pattern. I poured my roof in the fall, and some oak leaves had fallen onto the plywood before we poured, and now I have these pretty imprints of oak leaves on my ceiling.

But to make the concrete strong enough to support itself, it needs an internal grid of rebar. I must stress that I am not a structural engineer, but you could pay one to figure out the exact grid you’d need. I found different suggestions and did a conservative best guess to use 1/2 inch rebar in a 16 inch grid. Once you’ve laid them out, use baling wire or rebar ties to connect them together wherever they cross. Though not necessary, I bent the ends down so they would fit into the block cavities along the wall edge. Finally, place some small pieces of broken concrete block, which you are sure to have



laying around after building your block wall, underneath the rebar to raise the whole grid up off the plywood. The ideal placement is in the lower half of your roof, not the upper part. In my case, my roof slab was to be 5 inches thick, so I made sure the rebar was about 2 inches above the plywood.

Next, using a hefty hammer, or slipping a section of strong pipe over the upright vertical stubs of rebar coming *out* of your block walls, bend those stubs 90 degrees to the inside of your walls, and wire your grid to those stubs. When the roof is poured, those rebar will internally tie together your entire cellar, from footing up and around your roof, making it bombproof (or at least tornado proof)

Before you call the concrete truck to deliver your liquid roof, you'll need to tell them how much concrete you'll need. Brush off your high school geometry and start figuring volume. Measure from the inside edges of your form boards. Length x

width x height = volume. Make sure you use all the same units of measurement, and convert your final answer into cubic yards. I used feet measurement for all of my figuring. For example, a roof that is 8' by 10' and 2' thick would need 160 cubic feet of concrete, or almost 6 cubic yards. Since my roof was only 5 inches thick, I used 5/12 feet for my thickness, so in this example, I'd need 33.33 cubic feet or 1.25 cubic yards. There are very easy to use conversion websites online if your math skills are rusty. Remember your empty block cavities in the top course of your wall and add those in. Figure the volume for one and multiply for how many spaces you have; you don't want to be short on a concrete pour. If you have some variations in your form boards, round up, or even add an extra half yard to your order just in case.



When the truck comes to pour, help spread it around so it fills the form and make sure that the block cavities are filled down to the screen you placed below the last course of blocks. And remember to place your vertical vent pipe onto the round block you installed *before* you pour the concrete! Note the U-shaped elbow on top to keep out rain.

Use a long board to screed the concrete flat across the top of the form, and then let it cure. You don't need to do any extra



finishing on the surface since it will be buried and never seen again, (although I couldn't help myself and ended up troweling it smooth).

Congratulations! You have a cellar! Let it cure for a few days and then start removing the form boards and under structure that supported the plywood, and finally remove the plywood. (You'll use these to make your doors later.)

It's wise to have a few extra small forms sitting around that you put together using scrap wood, so if the truck has extra concrete, there is a place for them to pour it. They have to dump out all of the concrete before they leave, so it's best to have a place for it. I also ended up filling a small form that later became the hearth slab for our wood fired pizza oven. See that ebook, **The Backyard Bread and Pizza Oven**, if you need another fun project after this one.

Retaining Walls



The final step before the cellar is to build a pair of retaining walls out from the corners of the front wall to hold the earth fill that you will be piling back up on top of your root cellar. You could build this with more concrete block, and if so, it would be prudent to pour a footing for these walls. Or you could use the special retaining wall thick concrete bricks that landscapers use so much these days. Or you could use stone from your prop-

erty if you live in such a region. I chose to use broken chunks of concrete demolition, often called “urbanite”, which I could scavenge for free. I didn’t pour a footing, but I did use mortar to assemble them. I like the mosaic pattern that slowly evolved as I built them up, although the gathering of this urbanite and building the wall took much longer than I anticipated.



Plan to have them extending out at roughly 45 degree angle from the front wall. Note too, that you need to build up a smaller block wall on the roof above the exposed cellar front wall, to keep the earth that will be on top of the cellar from spilling off.

Covering the Cellar

Now it's time to cover your root cellar with dirt! It might be tempting to keep it as a small roller skating rink for your kids, or build a cute little garden shed on top of it, since it looks like the perfect foundation for a building. However, if you don't cover it up with at least a couple feet of dirt, it won't function as a root cellar, whose temperature is moderated by contact with earth all around it. So resist such temptations!



Some books and websites suggest putting down a layer of rigid foam insulation and then thick plastic sheeting over your roof before you cover it with earth. I'm not sure it really needs insulation, since it is the earth you are wanting to insulate and



mediate the temperature, but since I had a some scrap pieces from our house building, I put them down, and they formed a central raised area that the plastic draped over. The plastic seems prudent, since water can slowly weep through concrete. Because I didn't want to buy new plastic, I made use of some used plastic, adding several layers since they had holes.

Ideally, you will have just enough fill dirt from your excavation to mound over your cellar, thick enough to make it deeper than your frost line. If you have more, all the better. If you don't have enough, look into finding some free fill dirt.



This was our second rental expense - a skidskeer to cover the root cellar - but it was worth it. Most of our excavated fill ended up downhill of the cellar, and I can't imagine using a wheel barrow to do all that uphill moving.

In our case, I was only able to cover the roof with 1-2 feet of earth. I would've preferred to have more like 2-3 feet, but it seems to be doing the job.

Finally, sprinkle some straw over it and seed some erosion control cover crop grass to keep any heavy rains from eroding your artfully shaped mound of dirt.





Details

Doors

You will of course need a door. You'll want one that can withstand the elements from the outside and the humidity on the inside. If you are using it for a tornado shelter you will want one that is strong, and latches well from the inside. The height of this root cellar doesn't fit most common door sizes. You could cut one down to size, but that is harder to do with the exterior metal doors.



Door frames are needed before you hang your doors. I originally embedded threaded bolts to act as anchors for my door frame. But as I was working with them, they jiggled loose, so I eventually cut them off and used special concrete screws



with the brand named Tapcon to attach my frames. I used rot resistant white oak, but pressure treated would work too.

I planned to make my own doors, and it happily turned out that the 4 sheets of plywood I needed for the roof form were just enough to make my own insulated double plywood doors just the size I needed. After I installed my door sills, I was able to measure the exact size by just tracing through the opening onto the piece of plywood. This is great, particularly if you aren't the most exacting block layer like me, because you can cut your door to the slightly un-square opening that you end up with. I attached 2x4's on flat to that cut-to-size



piece of plywood, and filled the interior space with some left over rigid foam. Next I attached a second piece of plywood cut to the same size to sandwich it all together. Finally, I covered the outside surface of the plywood with a mosaic of small reclaimed oak barn siding for weather proofing. You could also paint it, or attach any other kind of exterior siding. The inner door doesn't need to be as strong, but you do need it to be as rot resistant as possible, because of the high humidity. I built one similar to the exterior door.

Porch Rain Overhang

Though not necessary, rain protection over the doorway is nice, so as I was laying the 3 courses of blocks above the



door as a retaining wall, I installed a few brackets into the mortar joint, to which I attached a ledger board for building a simple metal roof overhang that you can see above.

Safety Railing on Top of Cellar

Specifically because our kids spend a lot of time playing outside all over the homestead, we knew they would eventually find the exciting top of the root cellar, and since the drop from that spot is over 8 feet, we felt it would be prudent to put a visual barrier and safety railing there. I simply embedded some upright posts into some of the block cavities and anchored them with concrete, and attached an appropriately curved piece of round wood from our forest.



Shelving

Shelves are important and as varied as there are root cellar owners. You could bring in pre-made stainless steel shelving, or make your own with wood (oak or cedar preferably). I originally was going to figure ways to attach shelves directly to the block walls, but then read that it's good to have air flow around and behind the shelves, so I will be slowly building in free-standing shelves as I figure out where I want them.



Conclusion

We've now spent a year and a half with our root cellar, and it's been performing with all the simple non-electric grace we had hoped. We are excited to see it continually "settle in" to its environment, with grass and flowers growing on top and forest growing back in around the work site. Other than a few minor things I mentioned in the text of this book, I don't think I would have done anything different.

This year will be the first summer that it's been covered with earth, so I'm keen to monitor the temperatures in each chamber. Last summer, with the roof still exposed to sun and warm temperatures, our cellar got much warmer than desired.

What remains to be done is to slowly build in permanent shelving and storage bins. It's been helpful to have smaller portable shelving to use and move around to help us ascertain what and where we want the final shelving to be.

It's been humbling to build something so permanent and solid on this earth. Long after we are gone from this land, this cellar will still be patiently sitting, keeping its dark quiet insides cool and safe for whomever might be living here.



Additional Resources



Further Reading

We were greatly reliant on Mike and Nancy Bubel's 1979 book *Root Cellaring*, Rodale Press. (Not only did we generally base our design on the one they detail in their book, but we were inspired by a whole array of modern and historic root cellars that the Bubels profiled in their book. In addition, the first section of their book goes into great detail about how to prepare a variety of foods for cellaring and the optimal storage temperatures at which to keep food. Finally, if you plan on building a root cellar on flat non-sloping land, they have plans in here for that, and the drainage issues you will need to deal with).

MacKenzie, Jennifer, and Steve Maxwell *The Complete Root Cellar Book*. Toronto: Robert Rose, Inc., 2010. (Gives detailed, illustrated construction guides for making four different kinds of root cellars).

Mother Earth News: motherearthnews.com. (Online magazine features sustainable living information, including "Build a Basement Root Cellar").

Hartzberg, R., Vaughan, B. and Greene, J., *The New Putting Food By*, Stephen Greene Press, Brattleboro, VT, 1982. (Comprehensive food preservation resource with a section on root cellaring).

Terra Vivante *Keeping Food Fresh* Chelsea Green Publishing, 1999 (A great food preservation book focusing on old world techniques, with a whole section on root cellaring ideas, and smaller in-ground storage ideas).

Carol Huppung *Stocking Up III*, Rodale Press, Inc. 1986 (The classic comprehensive food preservation guide, with a section on root cellaring ideas you can try if you don't have an actual root cellar.)

About the Authors

Brian Thomas and Teri Page live in NE Missouri with their two children, where they have built an off the grid homestead from scratch. In addition to being a builder, Brian is also an artist blacksmith, and sells his work in their Etsy shop, [Acorn Hill Handcrafts](#) and co-wrote the ebook [The Backyard Bread and Pizza Oven](#). Teri is the creator of the popular homesteading blog, [Homestead Honey](#), and is the author of the ebook, [Creating Your Off-Grid Homestead](#), as well as a life and business coach for women.

